MC33375, NCV33375 Series

300 mA, Low Dropout Voltage Regulator with On/Off Control

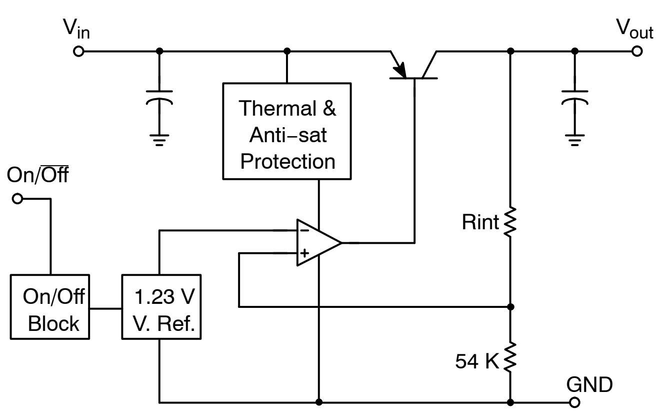
The MC33375 series are micropower low dropout voltage regulators available in a wide variety of output voltages as well as packages, SOT−223 and SOP−8. These devices feature a very low quiescent current and are capable of supplying output currents up to 300 mA. Internal current and thermal limiting protection are provided by the presence of a short circuit at the output and an internal thermal shutdown circuit.

The MC33375 has a control pin that allows a logic level signal to turn−off or turn−on the regulator output.

Due to the low input−to−output voltage differential and bias current specifications, these devices are ideally suited for battery powered computer, consumer, and industrial equipment where an extension of useful battery life is desirable.

Features:

- Low Quiescent Current (0.3 μA in OFF mode; 125 μA in ON mode)
- Low Input−to−Output Voltage Differential of 25 mV at I_O = 10 mA, and 260 mV at I_O = 300 mA
- Extremely Tight Line and Load Regulation
- Stable with Output Capacitance of only 0.33 μF for 2.5 V Output Voltage
- Internal Current and Thermal Limiting
- Logic Level ON/OFF Control
- NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable
- These are Pb−Free Devices



This device contains 41 active transistors

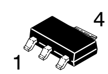
Figure 1. Simplified Block Diagram

ON Semiconductor®

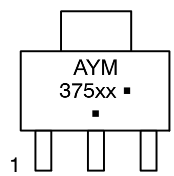
http://onsemi.com

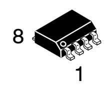
LOW DROPOUT MICROPOWER VOLTAGE REGULATOR

MARKING DIAGRAMS

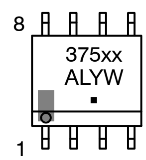


SOT−223
ST SUFFIX
CASE 318E





SOIC−8
D SUFFIX
CASE 751

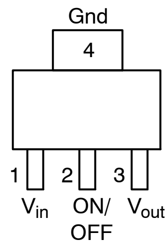


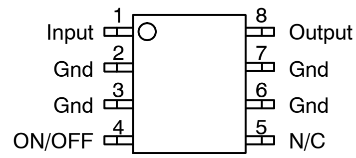
A = Assembly Location
Y = Year
M = Date Code
L = Wafer Lot
W = Work Week
xx = Voltage Version
▪ = Pb−Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 11 of this data sheet.

PIN CONNECTIONS





MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input Voltage	V_{CC}	13	Vdc
Power Dissipation and Thermal Characteristics T_A = 25°C Maximum Power Dissipation Case 751 (SOP−8) D Suffix Thermal Resistance, Junction−to−Ambient Thermal Resistance, Junction−to−Case Case 318E (SOT−223) ST Suffix Thermal Resistance, Junction−to−Air Thermal Resistance, Junction−to−Case	 P_D $R_{\theta JA}$ $R_{\theta JC}$ $R_{\theta JA}$ $R_{\theta JC}$	 Internally Limited 160 25 245 15	 W °C/W °C/W °C/W °C/W
Output Current	I_O	300	mA
Maximum Junction Temperature	T_J	150	°C
Operating Ambient Temperature Range	T_A	− 40 to +125	°C
Storage Temperature Range	T_{stg}	− 65 to +150	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

ELECTRICAL CHARACTERISTICS (C_L = 1.0 μF, T_A = 25°C, for min/max values T_J = −40°C to +125°C, Note 1)

Characteristic		Symbol	Min	Typ	Max	Unit
Output Voltage	I_O = 0 mA to 250 mA	V_O				Vdc
1.8 V Suffix	T_A = 25°C, V_{in} = [V_O + 1] V		1.782	1.80	1.818	
2.5 V Suffix			2.475	2.50	2.525	
3.0 V Suffix			2.970	3.00	3.030	
3.3 V Suffix			3.267	3.30	3.333	
5.0 V Suffix			4.950	5.00	5.05	
1.8 V Suffix	V_{in} = [V_O + 1] V, 0 < I_O < 100 mA		1.764	–	1.836	
2.5 V Suffix	2% Tolerance from T_J = −40 to +125°C		2.450	–	2.550	
3.0 V Suffix			2.940	–	3.060	
3.3 V Suffix			3.234	–	3.366	
5.0 V Suffix			4.900	–	5.100	
Line Regulation	V_{in} = [V_O + 1] V to 12 V, I_O = 250 mA, All Suffixes T_A = 25°C	Reg_{line}	–	2.0	10	mV
Load Regulation	V_{in} = [V_O + 1] V, I_O = 0 mA to 250 mA, All Suffixes T_A = 25°C	Reg_{load}	–	5.0	25	mV
Dropout Voltage (Note 3)		V_{in} − V_O				mV
I_O = 10 mA	T_J = −40°C to +125°C		–	25	100	
I_O = 100 mA			–	115	200	
I_O = 250 mA			–	220	400	
I_O = 300 mA			–	260	500	
Ripple Rejection (120 Hz)	$V_{in(peak-peak)}$ = [V_O + 1.5] V to [V_O + 5.5] V	–	65	75	–	dB
Output Noise Voltage		V_n				μVrms
C_L = 1.0 μF	I_O = 50 mA (10 Hz to 100 kHz)		–	160	–	
C_L = 200 μF			–	46	–	

CURRENT PARAMETERS

Characteristic		Symbol	Min	Typ	Max	Unit
Quiescent Current ON Mode	V_{in} = [V_O + 1] V, I_O = 0 mA	I_{QOn}	–	125	200	μA
Quiescent Current OFF Mode		I_{QOff}	–	0.3	4.0	μA
Quiescent Current ON Mode SAT	V_{in} = [V_O − 0.5] V, I_O = 0 mA (Note 2)	I_{QSAT}				μA
1.8 V Suffix			–	1100	1500	
2.5 V Suffix			–	1100	1500	
3.0 V Suffix			–	1500	2000	
3.3 V Suffix			–	1500	2000	
5.0 V Suffix			–	1500	2000	
Current Limit	V_{in} = [V_O + 1] V, V_O Shorted	I_{LIMIT}	–	450	–	mA

ON/OFF INPUTS

Characteristic	Symbol	Min	Typ	Max	Unit
On/Off Input Voltage	V_{CTRL}				V
Logic “1” (Regulator On) V_{out} = V_O ± 2%		2.4	–	–	
Logic “0” (Regulator Off) V_{out} < 0.03 V		–	–	0.5	
Logic “0” (Regulator Off) V_{out} < 0.05 V (1.8 V Option)		–	–	0.3	

THERMAL SHUTDOWN

Characteristic	Symbol	Min	Typ	Max	Unit
Thermal Shutdown	–	–	150	–	°C

1. Low duty pulse techniques are used during test to maintain junction temperature as close to ambient as possible.
2. Quiescent Current is measured where the PNP pass transistor is in saturation. V_{in} = [V_O − 0.5] V guarantees this condition.
3. For 1.8 V version V_{DO} is constrained by the minimum input voltage of 2.5 V.

DEFINITIONS

Load Regulation – The change in output voltage for a change in load current at constant chip temperature.

Dropout Voltage – The input/output differential at which the regulator output no longer maintains regulation against further reductions in input voltage. Measured when the output drops 100 mV below its nominal value (which is measured at 1.0 V differential), dropout voltage is affected by junction temperature, load current and minimum input supply requirements.

Output Noise Voltage – The RMS AC voltage at the output with a constant load and no input ripple, measured over a specified frequency range.

Maximum Power Dissipation – The maximum total dissipation for which the regulator will operate within specifications.

Quiescent Current – Current which is used to operate the regulator chip and is not delivered to the load.

Line Regulation – The change in output voltage for a change in the input voltage. The measurement is made under conditions of low dissipation or by using pulse techniques such that the average chip temperature is not significantly affected.

Maximum Package Power Dissipation – The maximum package power dissipation is the power dissipation level at which the junction temperature reaches its maximum value i.e. 150°C. The junction temperature is rising while the difference between the input power (V_{CC} X I_{CC}) and the output power (V_{out} X I_{out}) is increasing.

Depending on ambient temperature, it is possible to calculate the maximum power dissipation and so the maximum current as following:

$$Pd = \frac{T_J - T_A}{R_{\theta JA}}$$

The maximum operating junction temperature T_J is specified at 150°C, if T_A = 25°C, then P_D can be found. By neglecting the quiescent current, the maximum power dissipation can be expressed as:

$$I_{out} = \frac{P_D}{V_{CC} - V_{out}}$$

The thermal resistance of the whole circuit can be evaluated by deliberately activating the thermal shutdown of the circuit (by increasing the output current or raising the input voltage for example).

Then you can calculate the power dissipation by subtracting the output power from the input power. All variables are then well known: power dissipation, thermal shutdown temperature (150°C for MC33375) and ambient temperature.

$$R_{\theta JA} = \frac{T_J - T_A}{P_D}$$

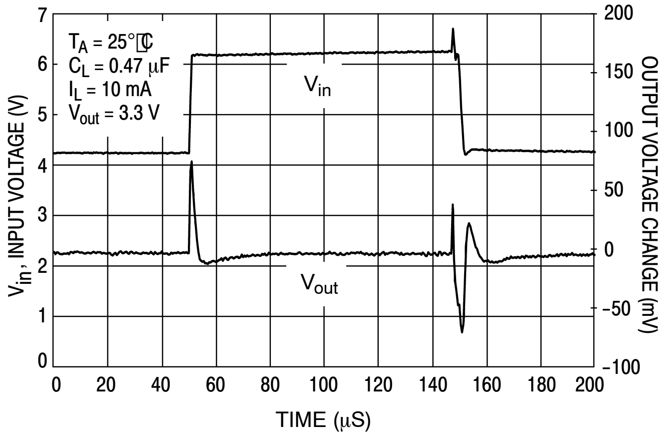


Figure 2. Line Transient Response

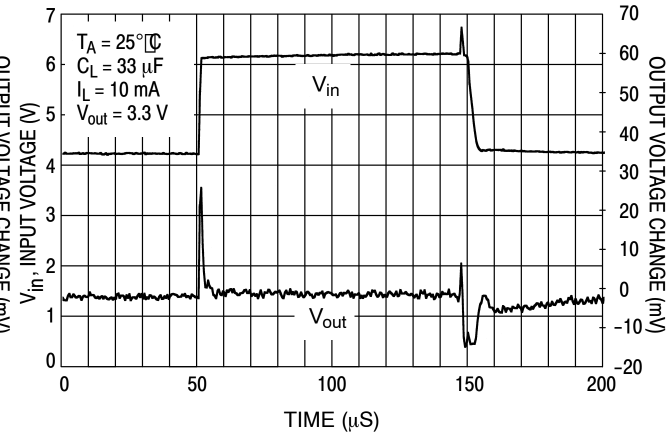


Figure 3. Line Transient Response

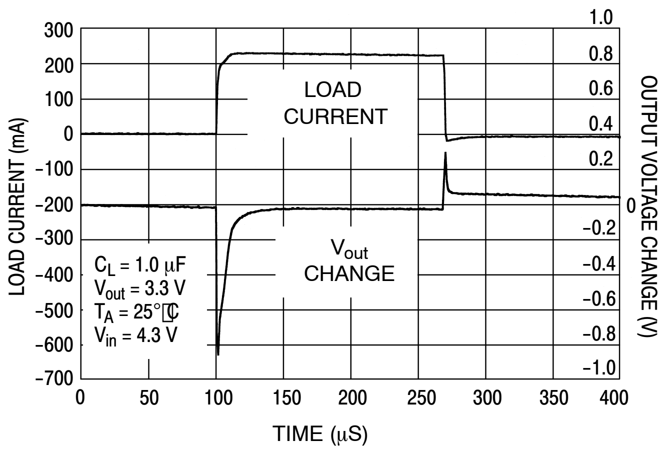


Figure 4. Load Transient Response

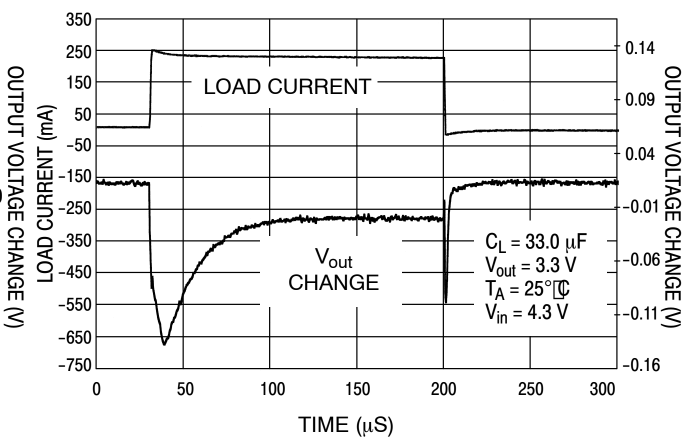


Figure 5. Load Transient Response

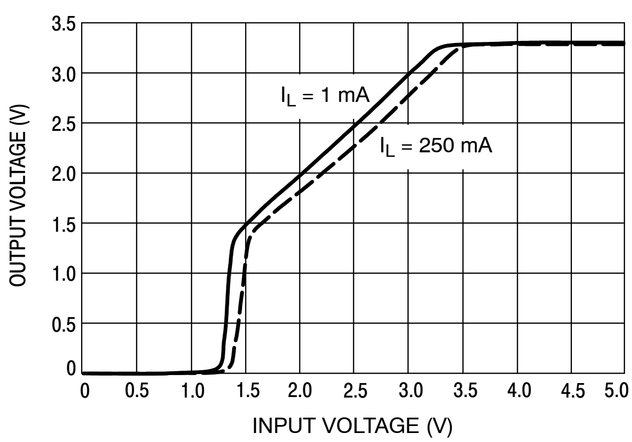


Figure 6. Output Voltage versus Input Voltage

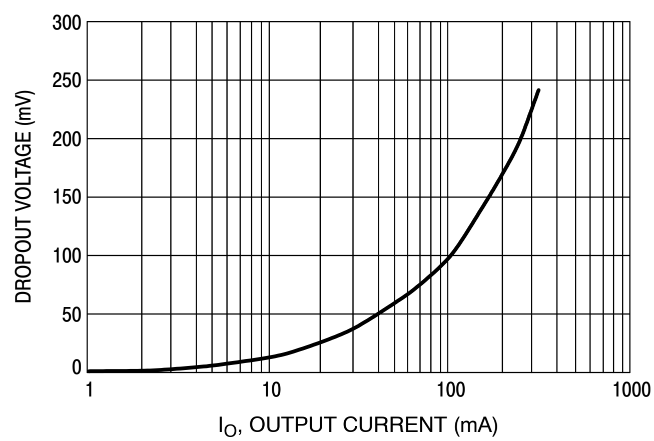


Figure 7. Dropout Voltage versus Output Current

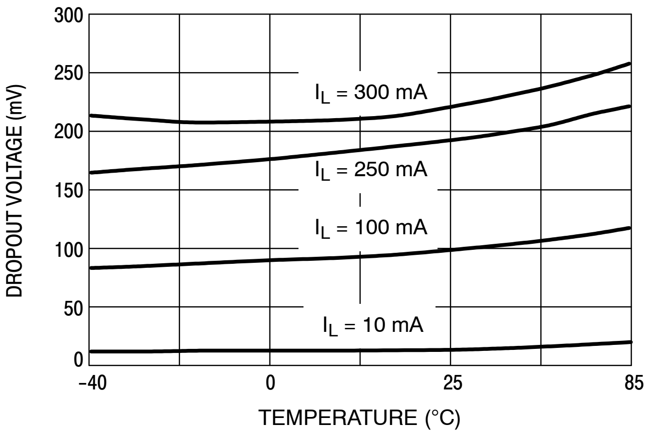


Figure 8. Dropout Voltage versus Temperature

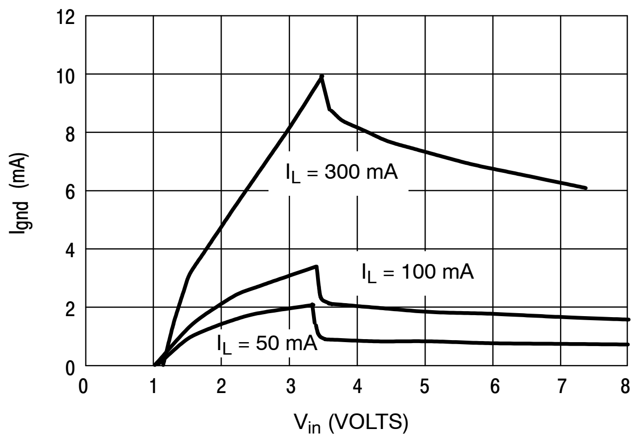


Figure 9. Ground Pin Current versus Input Voltage

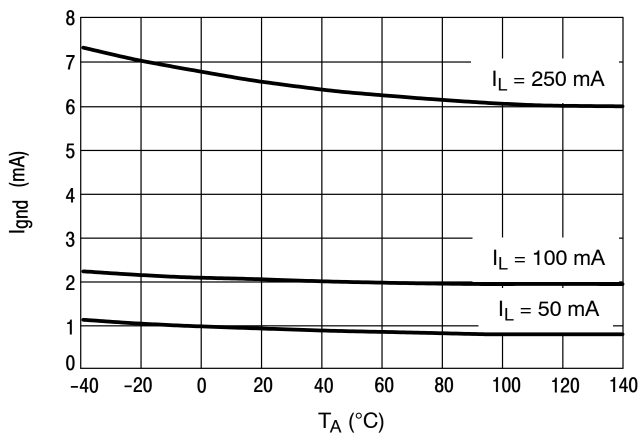


Figure 10. Ground Pin Current versus Ambient Temperature

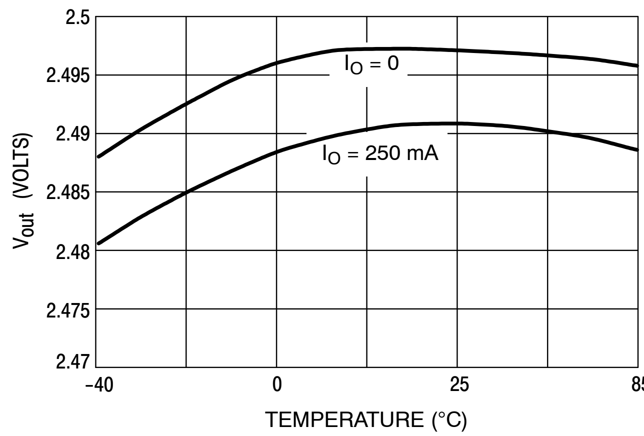


Figure 11. Output Voltage versus Ambient Temperature (V_{in} = V_{out} + 1V)

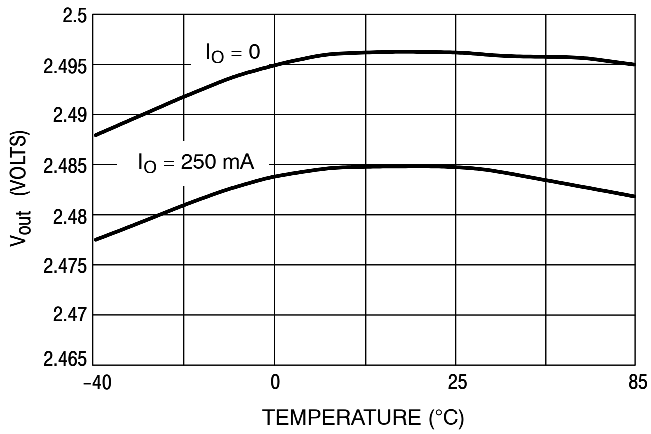


Figure 12. Output Voltage versus Ambient Temperature (V_{in} = 12 V)

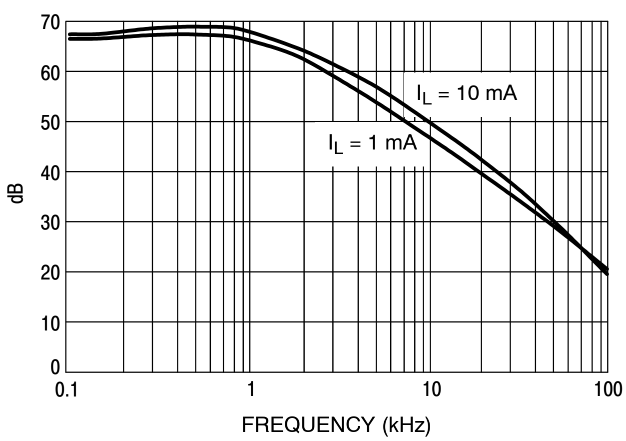


Figure 13. Ripple Rejection

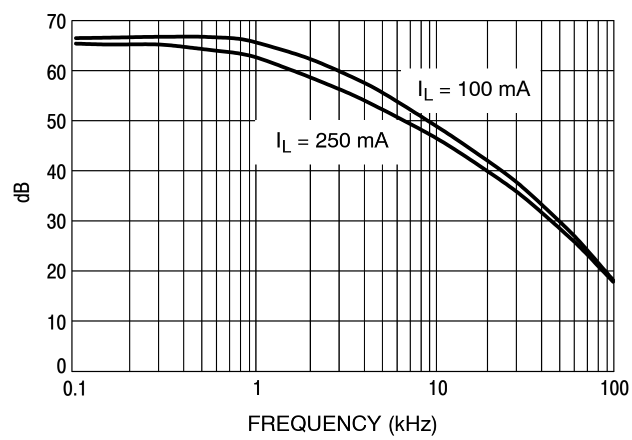


Figure 14. Ripple Rejection

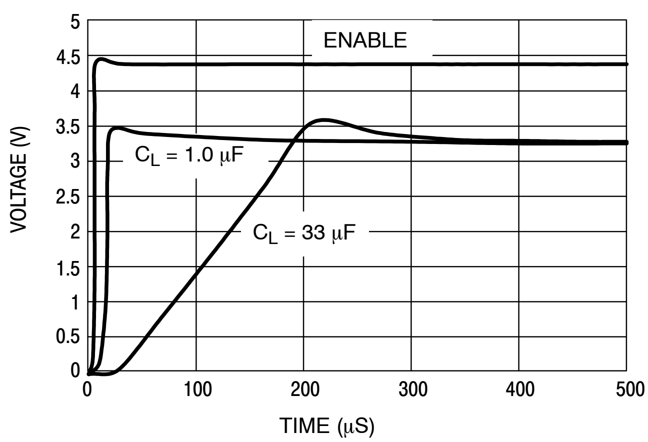


Figure 15. Enable Transient

1.8 V Option

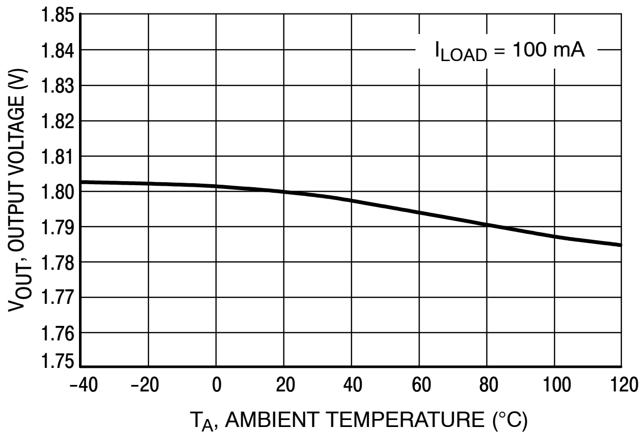


Figure 16. Output Voltage versus Temperature

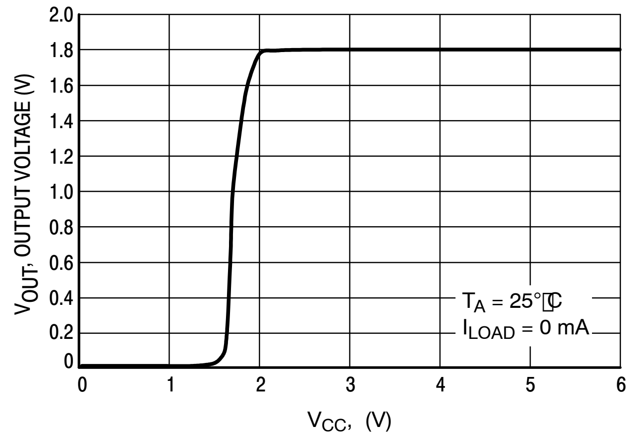


Figure 17. Output Voltage versus Input Voltage

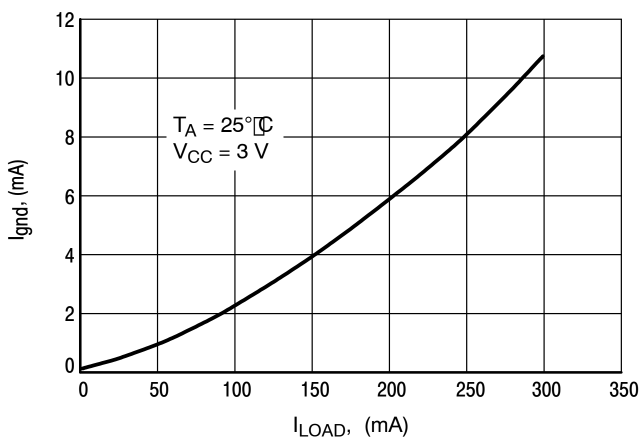


Figure 18. Ground Current versus Load Current

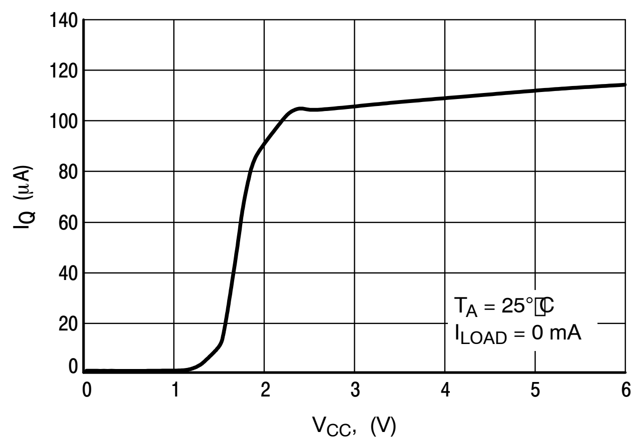


Figure 19. Quiescent Current versus Input Voltage

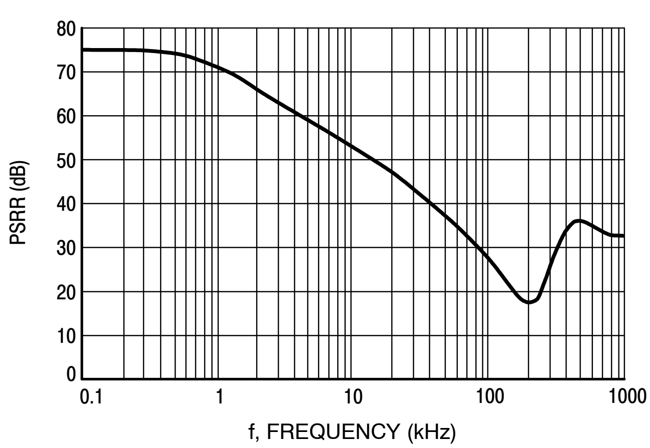


Figure 20. PSRR versus Frequency

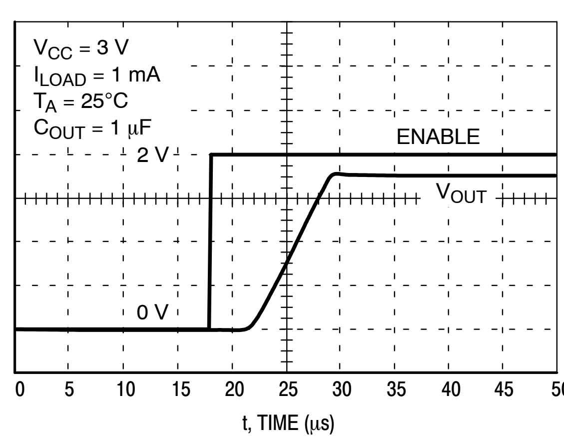


Figure 21. Enable Response

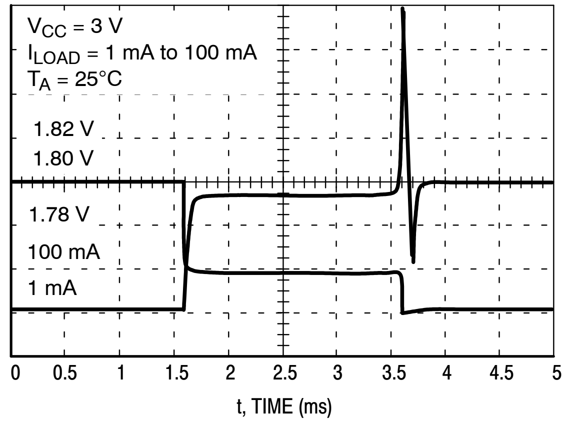


Figure 22. Load Transient Response

APPLICATIONS INFORMATION

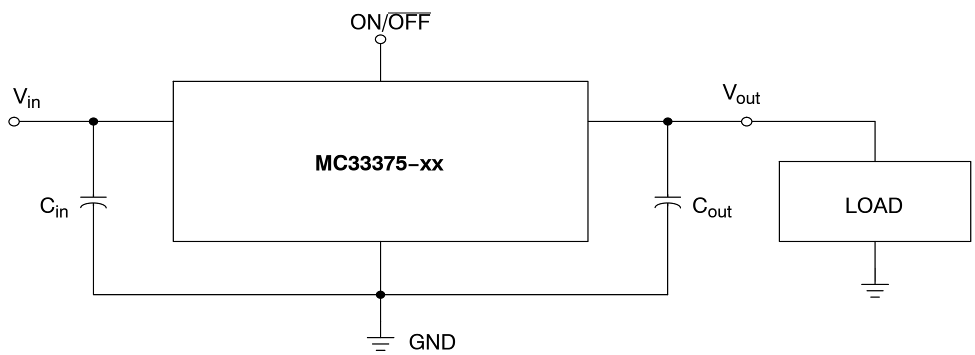


Figure 23. Typical Application Circuit

The MC33375 regulators are designed with internal current limiting and thermal shutdown making them user−friendly. Figure 15 is a typical application circuit. The output capability of the regulator is in excess of 300 mA, with a typical dropout voltage of less than 260 mV. Internal protective features include current and thermal limiting.

EXTERNAL CAPACITORS

These regulators require only a 0.33 μF (or greater) capacitance between the output and ground for stability for 1.8 V, 2.5 V, 3.0 V, and 3.3 V output voltage options. Output voltage options of 5.0 V require only 0.22 μF for stability. The output capacitor must be mounted as close as possible to the MC33375. If the output capacitor must be mounted further than two centimeters away from the MC33375, then a larger value of output capacitor may be required for stability. A value of 0.68 μF or larger is recommended. Most type of aluminum, tantalum, or multilayer ceramic will perform adequately. Solid tantalums or appropriate multilayer ceramic capacitors are recommended for operation below 25°C. An input bypass capacitor is recommended to improve transient response or if the regulator is connected to the supply input filter with long wire lengths, more than 4 inches. This will reduce the circuit's sensitivity to the input line impedance at high frequencies. A 0.33 μF or larger tantalum, mylar, ceramic, or other capacitor having low internal impedance at high frequencies should be chosen. The bypass capacitor should be mounted with shortest possible lead or track length directly across the regulator's input terminals. Figure 16 shows the ESR that allows the LDO to remain stable for various load currents.

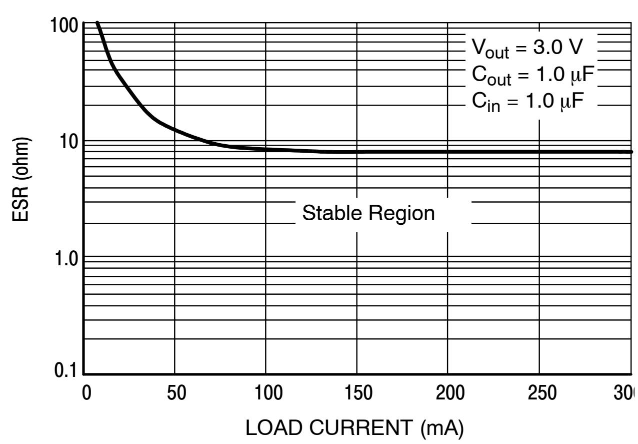


Figure 24. ESR for V_{out} = 3.0V

Applications should be tested over all operating conditions to insure stability.

THERMAL PROTECTION

Internal thermal limiting circuitry is provided to protect the integrated circuit in the event that the maximum junction temperature is exceeded. When activated, typically at 150°C, the output is disabled. There is no hysteresis built into the thermal protection. As a result the output will appear to be oscillating during thermal limit. The output will turn off until the temperature drops below the 150°C then the output turns on again. The process will repeat if the junction increases above the threshold. This will continue until the existing conditions allow the junction to operate below the temperature threshold.

Thermal limit is not a substitute for proper heatsinking.

The internal current limit will typically limit current to 450 mA. If during current limit the junction exceeds 150°C, the thermal protection will protect the device also. **Current limit is not a substitute for proper heatsinking.**

OUTPUT NOISE

In many applications it is desirable to reduce the noise present at the output. Reducing the regulator bandwidth by increasing the size of the output capacitor will reduce the noise on the MC33375.

ON/OFF PIN

When this pin is pulled low, the MC33375 is off. This pin should not be left floating. The pin should be pulled high for the MC33375 to operate.

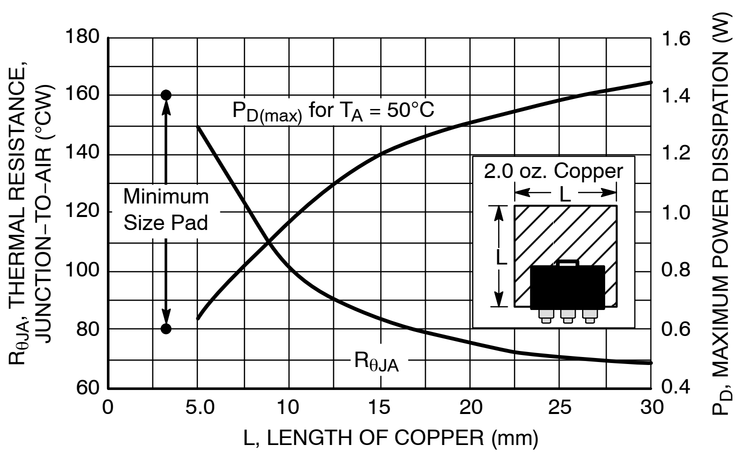


Figure 25. SOT−223 Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length

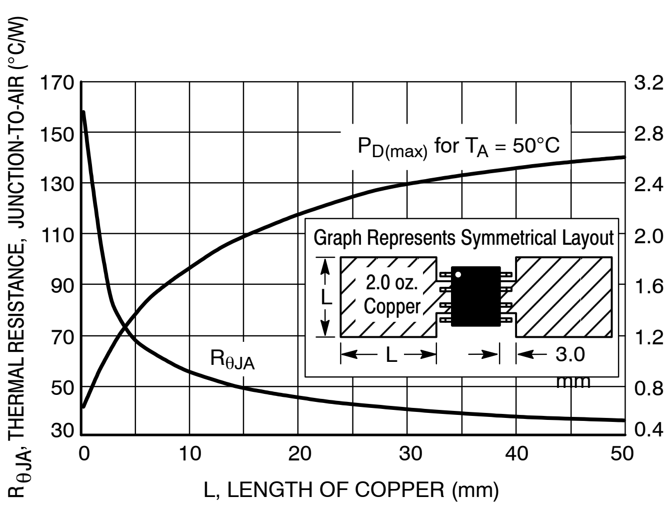


Figure 26. SOP−8 Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length

ORDERING INFORMATION

Device	Type	Operating Temperature Range, Tolerance	Package	Shipping†
MC33375ST−1.8T3G	1.8 V (Fixed Voltage)	1% Tolerance at T_A = 25°C 2% Tolerance at T_J from −40 to +125°C	SOT−223 (Pb−Free)	4000 / Tape & Reel
NCV33375ST1.8T3G*				
MC33375D−2.5G	2.5 V (Fixed Voltage)		SOIC−8 (Pb−Free)	98 Units / Rail
MC33375D−2.5R2G			SOIC−8 (Pb−Free)	2500 / Tape & Reel
NCV33375D−2.5R2G*				
MC33375ST−2.5T3G			SOT−223 (Pb−Free)	4000 / Tape & Reel
MC33375D−3.0G	3.0 V (Fixed Voltage)		SOIC−8 (Pb−Free)	98 Units / Rail
MC33375D−3.0R2G			SOIC−8 (Pb−Free)	2500 / Tape & Reel
MC33375ST−3.0T3G			SOT−223 (Pb−Free)	4000 / Tape & Reel
MC33375D−3.3G	3.3 V (Fixed Voltage)		SOIC−8 (Pb−Free)	98 Units / Rail
MC33375D−3.3R2G			SOIC−8 (Pb−Free)	2500 / Tape & Reel
NCV33375D−3.3R2G*				
MC33375ST−3.3T3G			SOT−223 (Pb−Free)	4000 / Tape & Reel
NCV33375ST3.3T3G*				
MC33375D−5.0G	5.0 V (Fixed Voltage)		SOIC−8 (Pb−Free)	98 Units / Rail
MC33375D−5.0R2G			SOIC−8 (Pb−Free)	2500 / Tape & Reel
MC33375ST−5.0T3G			SOT−223 (Pb−Free)	4000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.
*NCV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC−Q100 Qualified and PPAP Capable

DEVICE MARKING

Device	Version	Marking (1st line)
MC33375, NCV33375	1.8 V	37518
MC33375, NCV33375	2.5 V	37525
MC33375	3.0 V	37530
MC33375, NCV33375	3.3 V	37533
MC33375	5.0 V	37550

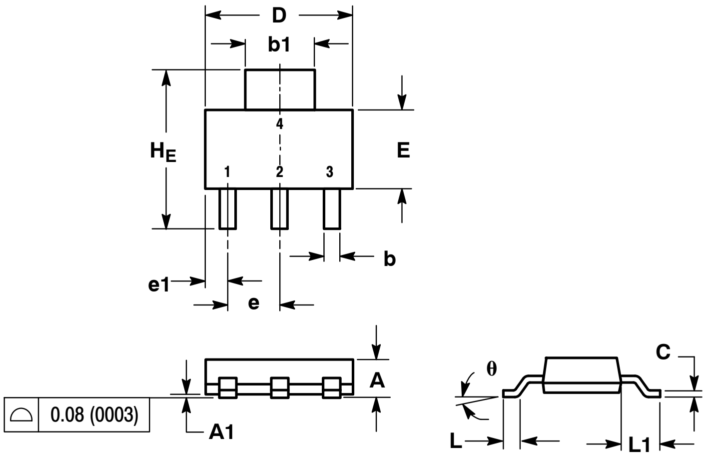
TAPE AND REEL SPECIFICATIONS†

Device	Reel Size	Tape Width	Quantity
MC33375D, NCV33375D	13″	12 mm Embossed Tape	2500 Units
MC33375ST, NCV33375ST	13″	8 mm Embossed Tape	4000 Units

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

PACKAGE DIMENSIONS

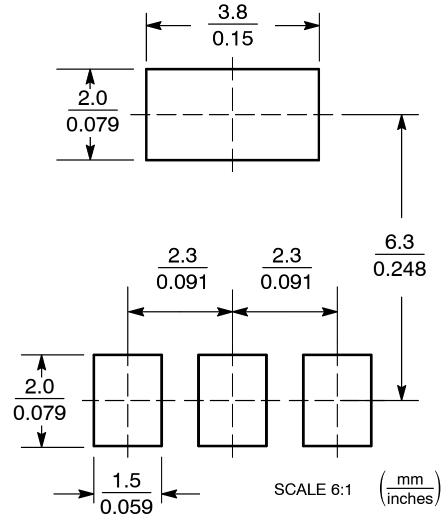
SOT−223 (TO−261)
CASE 318E−04
ISSUE N



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCH.

	MILLIMETERS			INCHES		
DIM	MIN	NOM	MAX	MIN	NOM	MAX
A	1.50	1.63	1.75	0.060	0.064	0.068
A1	0.02	0.06	0.10	0.001	0.002	0.004
b	0.60	0.75	0.89	0.024	0.030	0.035
b1	2.90	3.06	3.20	0.115	0.121	0.126
c	0.24	0.29	0.35	0.009	0.012	0.014
D	6.30	6.50	6.70	0.249	0.256	0.263
E	3.30	3.50	3.70	0.130	0.138	0.145
e	2.20	2.30	2.40	0.087	0.091	0.094
e1	0.85	0.94	1.05	0.033	0.037	0.041
L	0.20	−−−	−−−	0.008	−−−	−−−
L1	1.50	1.75	2.00	0.060	0.069	0.078
H_E	6.70	7.00	7.30	0.264	0.276	0.287
θ	0°	–	10°	0°	–	10°

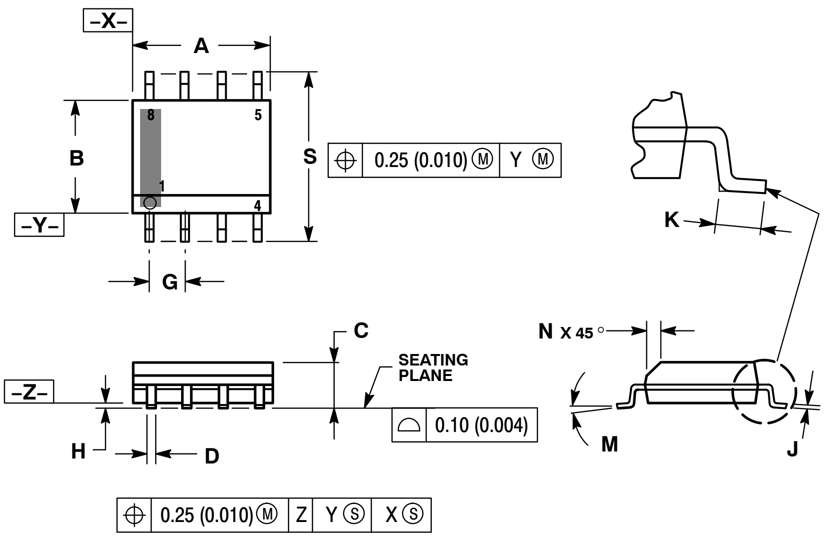
SOLDERING FOOTPRINT*



*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

PACKAGE DIMENSIONS

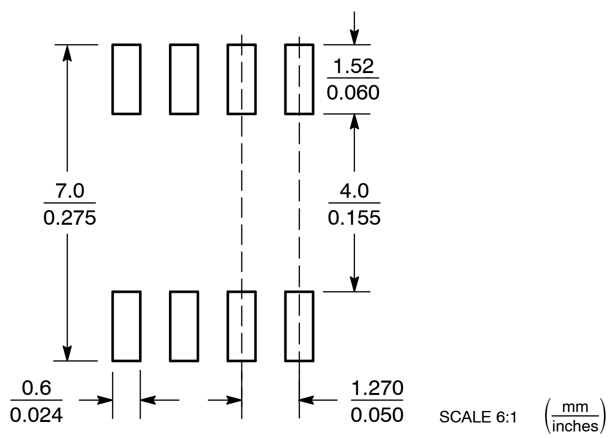
SOIC−8 NB
CASE 751−07
ISSUE AK



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. 751−01 THRU 751−06 ARE OBSOLETE. NEW STANDARD IS 751−07.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	4.80	5.00	0.189	0.197
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.053	0.069
D	0.33	0.51	0.013	0.020
G	1.27 BSC		0.050 BSC	
H	0.10	0.25	0.004	0.010
J	0.19	0.25	0.007	0.010
K	0.40	1.27	0.016	0.050
M	0 °	8 °	0 °	8 °
N	0.25	0.50	0.010	0.020
S	5.80	6.20	0.228	0.244

SOLDERING FOOTPRINT*



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